

What is claimed is:

1. A color space converting apparatus for converting a color value of a first color space to a color value of a second color space, said color space converting apparatus comprises:

a first color space converting mechanism for converting the first color space color value to the second color space color value so as to eliminate deviation of converted a color value derived by converting the color value of the white point of the first color space to the second color space, and the color value of the white point of the second color space.

2. A color space converting apparatus according to claim 1 wherein the first color space converting mechanism comprises:

a plurality of color conversion tables, prepared for each combination of the first color space and second color space, having characteristics for matching a converted color value, derived by converting to the second color space the color value of the white point of the first color space, with the color value of the white point of the second color space;

selecting means for selecting, on the basis of a combination of the first color space and the second color space, one color conversion table from among the plurality of color conversion tables; and

second color space converting means for converting a color value of the first color space to a color value of the second color space using the selected color conversion table.

3. A color space converting apparatus according to claim 1 wherein the first color space converting mechanism comprises:

a plurality of color conversion matrices, prepared for each combination of the first color space and second color space, having characteristics for matching a

converted color value, derived by converting to the second color space the color value of the white point of the first color space, with the color value of the white point of the second color space;

selecting means for selecting, on the basis of a combination of the first color space and the second color space, one color conversion matrix from among the plurality of color conversion matrices; and

third color space converting means for executing a matrix operation to convert a color value of the first color space to a color value of the second color space using the selected color conversion matrix.

4. A color space converting apparatus according to any one of claims 1 to 3 wherein the first color space and second color space are device-dependent color spaces dependent on a device, and

a first color value of a device-independent color space, derived by converting the color value of the white point of the first color space, is equal to a second color value of the device-independent color space, derived by converting the color value of the white point of the second color space.

5. A color space converting apparatus for converting a color value of a first color space to a color value of a second color space, said color space converting apparatus comprising:

color space converting means for performing a matrix operation to convert a color value of the first color space to a color value of the second color space;

deviation calculating means for calculating deviation of the color value of the achromatic color of the second color space with respect to a converted color value of the second color space, derived by executing the matrix operation on the color value of the achromatic color of the first color space; and

conversion accuracy improving means for reflecting the calculated deviation to improve color space conversion accuracy.

6. A color space converting apparatus according to claims 5 wherein the first color space and second color space are device-dependent color spaces dependent on a device, and

a first color value of a device-independent color space, derived by  
5 converting the color value of the achromatic color of the first color space, is equal to a second color value of the device-independent color space, derived by converting the color value of the achromatic color of the second color space.

7. A color space converting apparatus for matching the color value of the  
10 white point of a first color space with the color value of the white point of a second color space in a device-independent color space that is independent of any device, and converting a color value of the first color space to a color value of the second color space, said color space converting apparatus comprising:

a plurality of color conversion tables, prepared for each combination of the  
15 first color space and second color space, having characteristics for matching the color value of the white point of the second color space with a converted color value, derived by converting the color value of the white point of the first color space to the second color space using a third matrix generated on the basis of a first matrix for converting a color value of the first color space to a color value of  
20 the device-independent color space, and a second matrix for converting a color value of the second color space to a color value of the device-independent color space;

selecting means for selecting, on the basis of a combination of the first color space and the second color space, one color conversion table from among the  
25 plurality of color conversion tables; and

color space converting means for converting a color value of the first color space to a color value of the second color space using the selected color conversion table.

8. A color space converting apparatus for matching the color value of the white point of a first color space with the color value of the white point of a second color space in a device-independent color space that is independent of any device, and converting a color value of the first color space to a color value of the second color space, said color space converting apparatus comprising:

color space converting means for converting a color value of the first color space to a color value of the second color space using a third matrix created on the basis of a first matrix for converting a color value of the first color space to a color value of the device-independent color space and a second matrix for converting a color value of the second color space to a color value of the device-independent color space;

deviation calculating means for calculating deviation of the color value of the achromatic color of the second color space with respect to a converted color value converted from the color value of the achromatic color of the first color space to a color value of the second color space by means of the converting means; and

conversion accuracy improving means for reflecting the calculated deviation to improve color space conversion accuracy by the converting means.

9. A color space converting apparatus according to claim 8 wherein the conversion accuracy improving means reflects the deviation and corrects the color value converted to a color value of the second color space.

10. A color space converting apparatus according to claim 8 wherein the conversion accuracy improving means reflects the deviation and corrects the third matrix to improve the conversion accuracy.

11. A color space converting apparatus for matching the color value of the white point of a first color space with the color value of the white point of a second color space in a device-independent color space that is independent of any device,

and converting a color value of the first color space to a color value of the second color space, said color space converting apparatus comprising:

a plurality of color conversion matrices, prepared for each combination of the first color space and second color space, having characteristics for matching a converted color value, derived by converting to the second color space the color value of the white point of the first color space, with the color value of the white point of the second color space;

selecting means for selecting, on the basis of a combination of the first color space and the second color space, one color conversion matrix from among the plurality of color conversion matrices; and

color space converting means for executing a matrix operation, using the selected color conversion matrix, to convert a color value of the first color space to a color value of the second color space.

12. A color space converting apparatus according to any of claims 7 to 11 further comprising:

file reading means for reading the color value and output control information from a file that includes within a single file the color value and the output control information, which stipulates output conditions for color values;

wherein the first color space is determined on the basis of the read output control information.

13. A color space converting apparatus for converting a color value of a first color space to a color value of a second color space, said color space converting apparatus comprising:

first converting means for converting a color value of the first color space to a color value of a device-independent color space using a first matrix;

second converting means for converting a color value of the second color space to a color value of the device-independent color space using a second matrix;

determining means for determining whether the color value of a first white point in the device-independent color space, converted from the color value of the white point of the first color space by the first converting means, matches the color value of a second white point in the device-independent color space, converted from the color value of the white point of the second color space by the second converting means;

third converting means for converting a color value of the first color space to a color value of the second color space using a third matrix created on the basis of the first matrix and the second matrix;

deviation calculating means that, in the event it is determined that the color value of the first white point and the color value of the second white point match, calculates deviation of the color value of the achromatic color of the second color space and a converted color value that has been converted by the third converting means from the color value of the achromatic color of the first color space to a color value of the second color space; and

conversion accuracy improving means for improving color space conversion accuracy by the third converting means on the basis of the calculated deviation.

14. A color space converting apparatus according to claim 13 further comprising:

first correcting means that, in the event it is determined that the color value of the first white point and the color value of the second white point do not match, corrects the second matrix so that the color value of the second white point matches the color value of the first white point.

15. A color space converting apparatus according to claim 13 further comprising:

second correcting means that, in the event it is determined that the color value of the first white point and the color value of the second white point do not

match, corrects the first matrix so that the color value of the first white point matches the color value of the second white point.

16. A color space converting apparatus for matching the white point in a first RGB color space with the white point in a second RGB color space in an XYZ color space, and converting a color value (R1, G1, B1) in the first RGB color space to a color value (R2, G2, B2) in the second RGB color space, wherein said color space converting apparatus comprises:

converting means for converting a color value (R1, G1, B1) of the first RGB color space to a color value (R2, G2, B2) of the second RGB color space by means of the following Equation 1, using a matrix  $L = N^{-1}M$  calculated in advance on the basis of a matrix M used for converting a color value in a first RGB color space to a color value of an XYZ color space, and a matrix N used for converting a color value in a second RGB color space to a color value of an XYZ color space;

$$\begin{pmatrix} R2 \\ G2 \\ B2 \end{pmatrix} = L \begin{pmatrix} R1 \\ G1 \\ B1 \end{pmatrix} = \begin{pmatrix} a3 & b3 & c3 \\ d3 & e3 & f3 \\ g3 & h3 & i3 \end{pmatrix} \begin{pmatrix} R1 \\ G1 \\ B1 \end{pmatrix} \quad \text{Equation 1}$$

deviation calculating means for calculating deviation of a color value (1, 1, 1) representing the white point of the second color space with respect to a converted white point color value ( $a3 + b3 + c3$ ,  $d3 + e3 + f3$ ,  $g3 + h3 + i3$ ), converted by the converting means from a color value (1, 1, 1) representing the white point of the first color space, to a color value representing the white point of the second color space; and

conversion accuracy improving means for reflecting the calculated deviation to improve color space conversion accuracy by the converting means.

17. A color space converting apparatus for converting a color value (R1, G1, B1) in a first RGB color space to a color value (R2, G2, B2) in a second RGB color space, wherein said color space converting apparatus comprises:

first converting means for converting a color value (R1, G1, B1) of the first RGB color space to a color value (X, Y, Z) of an XYZ color space by means of the following Equation 1, using a matrix M;

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix} = M \begin{pmatrix} R1 \\ G1 \\ B1 \end{pmatrix} = \begin{pmatrix} a1 & b1 & c1 \\ d1 & e1 & f1 \\ g1 & h1 & i1 \end{pmatrix} \begin{pmatrix} R1 \\ G1 \\ B1 \end{pmatrix} \quad \text{Equation 1}$$

- 5 second converting means for converting a color value (R2, G2, B2) of the second RGB color space to a color value (X, Y, Z) of an XYZ color space by means of the following Equation 2, using a matrix N;

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix} = N \begin{pmatrix} R2 \\ G2 \\ B2 \end{pmatrix} = \begin{pmatrix} a2 & b2 & c2 \\ d2 & e2 & f2 \\ g2 & h2 & i2 \end{pmatrix} \begin{pmatrix} R2 \\ G2 \\ B2 \end{pmatrix} \quad \text{Equation 2}$$

10 third converting means for converting a color value (R1, G1, B1) of the first RGB color space to a color value (R2, G2, B2) of the second RGB color space by means of the following Equation 3, using a matrix  $L = N^{-1}M$  calculated in advance on the basis of a matrix M and matrix N;

$$\begin{pmatrix} R2 \\ G2 \\ B2 \end{pmatrix} = L \begin{pmatrix} R1 \\ G1 \\ B1 \end{pmatrix} = \begin{pmatrix} a3 & b3 & c3 \\ d3 & e3 & f3 \\ g3 & h3 & i3 \end{pmatrix} \begin{pmatrix} R1 \\ G1 \\ B1 \end{pmatrix} \quad \text{Equation 3}$$

- 15 determining means for determining whether the three relationships  $a1 + b1 + c1 = a2 + b2 + c2$ ,  $d1 + e1 + f1 = d2 + e2 + f2$ , and  $g1 + h1 + i1 = g2 + h2 + i2$  are true for a color value of the XYZ color space derived by converting a color value (1, 1, 1) representing the white point of the first RGB color space by means of the first converting means, and a color value of the XYZ color space derived by converting a color value (1, 1, 1) representing the white point of the second RGB color space by means of the second converting means;
- 20

deviation calculating means that, in the event it is determined that the three relationships are true, calculates deviation of a color value (1, 1, 1) representing the white point of the second RGB color space with respect to a converted color value ( $a3 + b3 + c3$ ,  $d3 + e3 + f3$ ,  $g3 + h3 + i3$ ), converted by the third converting



means from a color value (1, 1, 1) representing the white point of the first RGB color space to a color value of the second RGB color space; and

first correcting means for correcting the coefficients of the matrix L so as to eliminate the calculated deviation.

5

18. A color space converting apparatus according to claim 17 further comprising:

second correcting means that, in the event that it is determined that at least one relationship of the three relationships is not true, corrects the matrix N.

10

19. A color space converting apparatus according to claim 17 further comprising:

third correcting means that, in the event that it is determined that at least one relationship of the three relationships is not true, corrects the matrix M.

15

20. A method of color space conversion for converting a color value of a first color space to a color value of a second color space, said method of color space conversion comprising:

20

converting a color value of the first color space to a color value of the second color space so as to eliminate deviation of the color value of the white point of the second color space from a converted color value converted to the second color space from the color value of the white point of the first color space.

25

21. A method of color space conversion for converting a color value of a first color space to a color value of a second color space, said method of color space conversion comprising:

30

determining whether the color value of a first white point converted from the color value of the white point of the first color space to a color value of a device-independent color space using a first matrix, matches the color value of a second white point converted from the color value of the white point of the second color

space to a color value of the device-independent color space using a second matrix;

when it is determined that the color value of the first white point and the color value of the second white point match, calculating deviation of the color value of the second white point with respect to a converted value converted to the second color space from the color value of the achromatic color of the first color space using a third matrix created on the basis of the first matrix and the second matrix; and

correcting the matrix coefficients of the third matrix so as to eliminate the calculated deviation.

22. A method of color space conversion for converting a color value (R1, G1, B1) in a first RGB color space to a color value (R2, G2, B2) in a second RGB color space, said method of color space conversion comprising:

determining whether the three relationships  $a1 + b1 + c1 = a2 + b2 + c2$ ,  $d1 + e1 + f1 = d2 + e2 + f2$ , and  $g1 + h1 + i1 = g2 + h2 + i2$  are true for a color value of the XYZ color space derived by converting a color value (1, 1, 1) representing the white point of the first color space using the following Equation 1 including a matrix M, and a color value of the XYZ color space derived by converting a color value (1, 1, 1) representing the white point of the second RGB color space using the following Equation 2 including a matrix N;

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix} = M \begin{pmatrix} R1 \\ G1 \\ B1 \end{pmatrix} = \begin{pmatrix} a1 & b1 & c1 \\ d1 & e1 & f1 \\ g1 & h1 & i1 \end{pmatrix} \begin{pmatrix} R1 \\ G1 \\ B1 \end{pmatrix} \quad \text{Equation 1}$$

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix} = N \begin{pmatrix} R2 \\ G2 \\ B2 \end{pmatrix} = \begin{pmatrix} a2 & b2 & c2 \\ d2 & e2 & f2 \\ g2 & h2 & i2 \end{pmatrix} \begin{pmatrix} R2 \\ G2 \\ B2 \end{pmatrix} \quad \text{Equation 2}$$

in the event it is determined that the three relationships are true, calculating deviation of a color value (1, 1, 1) representing the white point of the second color space with respect to a converted color value ( $a3 + b3 + c3$ ,  $d3 + e3 + f3$ ,  $g3 + h3$

+ i3), converted from a color value (1, 1, 1) representing the white point of the first color space to a color value of the second color space using the following Equation 3 including a matrix N precalculated on the basis of matrix M and matrix N; and

$$\begin{pmatrix} R2 \\ G2 \\ B2 \end{pmatrix} = L \begin{pmatrix} R1 \\ G1 \\ B1 \end{pmatrix} = \begin{pmatrix} a3 & b3 & c3 \\ d3 & e3 & f3 \\ g3 & h3 & i3 \end{pmatrix} \begin{pmatrix} R1 \\ G1 \\ B1 \end{pmatrix} \quad \text{Equation 3}$$

- 5                    correcting the coefficients of the matrix L so as to eliminate the calculated deviation.

23. A color space converting program for converting a color value of a first color space to a color value of a second color space, wherein said color space converting program realizes by means of a computer

a first color conversion function for converting a color value of the first color space to a color value of the second color space, in such a way as to eliminate deviation of a converted color value, derived by converting the color value of the white point of the first color space to the second color space, with respect to the color value of the white point of the second color space.

24. A color space converting program for matching the color value of the white point of a first color space with the color value of the white point of a second color space in a device-independent color space, and converting a color value of the first color space to a color value of the second color space, wherein said color space converting program realizes by means of a computer,

a function for calculating deviation of the color value of the white point of the second color space with respect to a converted color value that has been converted from the color value of the white point of the first color space to the second color space using a third matrix created on the basis of a first matrix for converting a color value of the first color space to a color value of the device-independent color space and a second matrix for converting a color value of the second color space to a color value of the device-independent color space; and

a function for improving conversion accuracy improving on the basis of the calculated deviation.

25. A color space converting program for converting a color value of a first color space to a color value of a second color space, wherein said color space converting program realizes by means of a computer

a function for determining whether the color value of a first white point converted to a device-independent color space from the color value of the white point of the first color space using a first matrix matches the color value of a second white point converted to a device-independent color space from the color value of the white point of the second color space using a second matrix;

a function that, in the event that that it is determined that the color value of the first white point and the color value of the second white point match, calculates deviation of the color value of achromatic color of the second color space with respect to a converted value converted to the second color space from the color value of the achromatic color of the first color space using a third matrix created on the basis of the first matrix and the second matrix; and

a function for reflecting the calculated deviation to improve the accuracy of the color conversion.

26. A color space converting program for converting a color value (R1, G1, B1) in a first RGB color space to a color value (R2, G2, B2) in a second RGB color space, wherein said color space converting program realizes by means of a computer,

a function for determining whether the three relationships  $a_1 + b_1 + c_1 = a_2 + b_2 + c_2$ ,  $d_1 + e_1 + f_1 = d_2 + e_2 + f_2$ , and  $g_1 + h_1 + i_1 = g_2 + h_2 + i_2$  are true for a color value of the XYZ color space derived by converting a color value (1, 1, 1) representing the white point of the first color space using the following Equation 1 including a matrix M, and a color value of the XYZ color space derived by

converting a color value (1, 1, 1) representing the white point of the second color space using the following Equation 2 including a matrix N;

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix} = M \begin{pmatrix} R1 \\ G1 \\ B1 \end{pmatrix} = \begin{pmatrix} a1 & b1 & c1 \\ d1 & e1 & f1 \\ g1 & h1 & i1 \end{pmatrix} \begin{pmatrix} R1 \\ G1 \\ B1 \end{pmatrix} \quad \text{Equation 1}$$

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix} = N \begin{pmatrix} R2 \\ G2 \\ B2 \end{pmatrix} = \begin{pmatrix} a2 & b2 & c2 \\ d2 & e2 & f2 \\ g2 & h2 & i2 \end{pmatrix} \begin{pmatrix} R2 \\ G2 \\ B2 \end{pmatrix} \quad \text{Equation 2}$$

- 5 a function that, in the event it is determined that the three relationships are true, calculates deviation of a color value (1, 1, 1) representing the white point of the second color space with respect to a converted color value (a3 + b3 + c3, d3 + e3 + f3, g3 + h3 + i3), converted from a color value (1, 1, 1) representing the white point of the first color space to a color value of the second color space using the following Equation 3 including a matrix N precalculated on the basis of matrix M and matrix N; and

$$\begin{pmatrix} R2 \\ G2 \\ B2 \end{pmatrix} = L \begin{pmatrix} R1 \\ G1 \\ B1 \end{pmatrix} = \begin{pmatrix} a3 & b3 & c3 \\ d3 & e3 & f3 \\ g3 & h3 & i3 \end{pmatrix} \begin{pmatrix} R1 \\ G1 \\ B1 \end{pmatrix} \quad \text{Equation 3}$$

a function for reflecting the calculated deviation to improve the accuracy of the color conversion.

15

27. A method for manufacture of a color space conversion matrix for converting a color value of a first color space to a color value of a second color space, said method for manufacture of a color space conversion matrix comprising:

- 20 executing a matrix operation to convert the color value of the white point of the first color space to a color value of the second color space;

calculating deviation between the color value of the second color space obtained by executing the matrix operation, and the color value of the achromatic color of the second color space;

correcting the matrix to reflect the calculated deviation so as to match the converted color value of the second color space with the color value of the achromatic color of the second color space, to calculate a corrected matrix; and storing the calculated matrix in storage means.

5

28. A method for manufacture of a color space conversion matrix according to claim 27 wherein the achromatic color of the second color space is white.

29. A method for manufacture of a color space conversion table for  
10 converting a color value of a first color space to a color value of a second color space, said method for manufacture of a color space conversion table comprising:

executing a matrix operation to convert the color value of the white point of the first color space to the color value of the white point of the second color space;

15 calculating deviation between the color value of the second color space obtained by executing the matrix operation and the color value of the achromatic color of the second color space;

correcting the matrix to reflect the calculated deviation so as to match the color value converted to the second color space with the color value of the achromatic color of the second color space;

20 executing a matrix operation using the calculated matrix to convert a plurality of color values of the first color space to a plurality of color values of the second color space;

creating a color space conversion table associating the plurality of color values of the first color space with the plurality of color values of the second color  
25 space; and

storing the created color space conversion table in storage means.

30. A method for manufacture of a color space conversion table according to claim 29 wherein the achromatic color of the second color space is white.